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ABSTRACT

Do children and adults who are novices in their use of microcomputers differ in their approaches when learning a computer language? Ten fourth- and fifth-grade students and 10 graduate students were observed learning the language BASIC on microcomputers. All sessions were tape recorded and verbalizations subsequently coded. Verbalizations, the number of computer operations executed, and the percentage of responses which were correct were compared for the two groups. The pattern of verbalizations was strikingly similar for children and adults. Monitoring and checking statements accounted for almost half of total verbal output, and questions to the examiner accounted for one quarter. Adults, more often than children, expressed negative comments about the computer. Although computer output for adults was greater than for children, there was no significant difference in the percentage of correct responses for the two groups. Possible explanations for these performance similarities and for the potential of the computer as an equalizer between young and old are discussed. (Author)

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Differences between Children and Adults in Learning Basic on Microcomputers

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Running head: Children vs. Adults Learn Basic

* This study comes out of the Electronic Learning Laboratory, Box 227, Teachers College, Columbia University, of which Mary Alice White, Ph.D., is director.

Abstract

Do children and adults who are novices in their use of microcomputers differ in their approach when learning a computer language? Ten fourth and fifth grade students and ten graduate students were observed learning the language Basic on microcomputers. All sessions were tape recorded and verbalizations subsequently coded. Verbalizations, the number of computer operations executed, and the percentage of the responses which were correct were compared for the two groups. The pattern of verbalizations were strikingly similar for children and adults. Monitoring and checking statements accounted for almost half of their total verbal output, and questions to the examiner for one quarter. Adults more often than children expressed negative comments about the computer. Although computer output for adults was greater than for children, there was no significant difference in the percentage of correct responses for the two groups. Possible explanations for these performance similarities, and the potential of the computer as an equalizer between young and old were discussed.

Differences between Children and Adults in Learning Basic on Microcomputers

About one half of the nation's school districts provide students with access to at least one microcomputer or computer terminal according to a survey conducted by the U.S. Department of Education in 1980. The rapid growth of microcomputers bought for home and personal use has been widely reported in the media. Although children and adults are learning more and more via microcomputers, psychologists have paid little attention to this form of learning.

Much of the research by cognitive psychologists on children's and adult's learning has focused on problem solving in traditional academic disciplines like reading, mathematics and physics. Based on this research, some psychologists argue for the existence of central strategies of thinking (Barron, 1978; Brown, 1978; Resnick, 1976). Brown and DeLouche (1978) believe central strategies, which they term "metacognition", include activities like predicting, checking, monitoring, reality testing and other behaviors to coordinate and control attempts to learn or solve problems. These activities are considered to be basic characteristics of thinking efficiently in a wide range of learning situations.

Novices often fail to perform efficiently, not only because they may lack certain skills, but because they are deficient in

metacognition and intelligent self-regulation (Brown & DeLouche, 1978). This deficit is not necessarily related to age per se but may be more a function of inexperience in a new problem situation. For example, in one experiment children and adults exhibited typical developmental trends for recall of digits. However, when chess materials were used and children had greater knowledge of chess than adults, the children exhibited better recall than adults. (Chi, 1978). Children more often than adults are novices in problem solving situations and therefore experience greater difficulty on most tasks.

Do these findings apply when we look at learning with microcomputers? In one recent study, Chernick & White (1981) found differences in children's learning in computer versus traditional classroom settings. Pupils in the computer setting questioned more and participated more actively. However, the content and verbal operation level of student and computer questions were more restricted in the computer than classroom setting. In this study students worked on drill and practice and simulation programs. A more cognitively challenging task may be learning a programming language, and therefore a better sample of problem solving ability.

Weinberg (1971) describes programming as a unique form of communication in which human beings take an active role and machines often a passive one. The programming language Basic has established itself as the language most frequently used to teach children and

adults how to program computers (Papert, 1980).

The present study was designed to observe and evaluate the performance of children and adults learning the computer language Basic. The question was posed: Do children and adults who are novices in their use of microcomputers differ in their approach when learning a computer language?

Method

Subjects

Ten adults and ten children participated in this study. The adults were all graduate level students from a private university in New York City. There were six females and four males, ranging in age from 23 to 40 years, of whom eight were Caucasian and two black. The sample of children consisted of four fifth grade students and six sixth grade students, ranging in age from 10 to 12 years, from a parochial school in the suburbs of New York. The school draws its population from an upper middle class income area. The students' parents are mostly college graduates and many are professionals with advanced degrees. Three of the students were male, seven were female and all were Caucasian. None of the subjects had prior experience with a computer language and the majority of the subjects had never worked on a microcomputer.

Apparatus

The subjects in the study operated an Apple II microcomputer displayed on a 15 inch Sony Trinitron KV-1514 color television.

The subjects used the Applesoft Tutorial published by the Apple Computer Inc., a self-teaching guide for the language Basic. All sessions were tape recorded using an Audiotronics cassette recorder 148A.

Procedure

After a brief introduction on how a computer operates and an explanation of what a programming language is, each subject was handed an edited version of the Applesoft Tutorial and told to work through it at their own pace. The manual had been edited and abbreviated by the examiner to focus on specific exercises and concepts so that each subject would be able to execute at least one program within the session.

Each subject was observed individually for a 45 minute session. There was a total of 15 hours of observation. One modification in this procedure was made for the children. Parts of the manual, which were found through piloting sessions to be difficult for the children to read, were read aloud verbatim by the examiner. All verbalizations by the subjects during the sessions were tape recorded and all operations on the computer were recorded by the examiner during the sessions.

Verbalizations by the subjects were transcribed and subsequently coded into the following categories: 1. questioning - questions were categorized either as being addressed to oneself or the computer, or to the examiner; 2. planning statements - statements

which indicated the subject was planning additions or modifications to a program, talking outloud about subsequent operations on the computer; 3. monitoring statements - included activities like reading messages from the computer screen, reading the manual outloud, verifying work already accomplished, talking outloud as one worked; 4. evaluating statements - responses in this category were divided according to whether the statements expressed praise or criticism towards a subject's own performance or if they praised or criticized the performance of the computer; and 5. non-computer related - were those responses which did not relate to any aspect of the computer work. If a response contained two sentences each sentence was coded individually regardless if they fell in the same category.

The number of computer operations executed by each subject was totaled as well as the number of errors made. An operation was considered completed when the key "return" was pressed by the subject. Thus one line in a program, or a command such as "New", or clearing the screen, were each counted as one operation. Only one error was counted per operation; if a subject made one or three errors within one line of his or her program it was counted as one error. Self-corrected errors were not counted.

After a training session, a second rater independently coded 189 verbal responses and 150 computer operations. Reliability

was calculated by the formula: number of agreements divided by agreements plus disagreements x 100. Average inter-observer reliability for the verbal responses was .88 and .96 for the computer operations.

To determine the effect the examiner had on the questioning behavior of the subjects, observations were made in a private school of a teacher working with seventh grade students who were novices at programming with Basic. One teacher and four students were observed. For two students the situation simulated closely that of this study in that there was minimal opportunity for interaction with peers and the teacher was readily available. The other two students were observed in a situation where there was minimal opportunity to interact with the teacher but student aid was available. All verbalizations during the observations were tape recorded. A comparison of the questioning behavior of students in this school to that of the subjects in the study was made and the results are presented below.

Results

The percentage of verbalizations in each category emitted by adults compared to children is presented in Table 1. The

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Insert Table 1 about here

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pattern of verbalizations were strikingly similar for the two groups. Adults and children talked an equal amount and monitoring and checking statements accounted for 46% of their total verbal output.

About one quarter of each group's verbalizations were questions directed to the examiner. It appears that the manual alone was not sufficient as a tutor.

The percentage of questioning behavior was reliable across settings. In the private school where a second teacher was observed, questions to the teacher accounted for 27% of the students' verbalizations; for the two students who had access to aid from peers and only sporadically from a teacher, 25% of their verbalizations were directed to a peer and 3% to the teacher. Questioning seems to be an important means by which students gain information about a computer language but what resources are available seems to determine who these questions will be addressed to.

Surprisingly, adults and children made about equal planning statements (9% and 12%, respectively). For evaluative statements the greatest difference between adults and children was in computer negative responses. Adults more often than children expressed negative comments about the computer (7% to 2%, respectively).

One other finding is worth noting. During fifteen hours of observation, non-computer related behavior was almost non-existent. Only seven out of the 1,964 verbalizations emitted fell in this

category, or .3%!

Computer operations are analyzed in Table 2. The number of operations, errors and the percentage of correct responses for adults and children are included in the table.

Insert Table 2 about here

Although computer output for adults was greater than for children (1.6 to 1, respectively) there was no significant difference in the percentage of correct responses between the two groups (83% for adults, 79% for children, $t(18) = .290$).

Discussion

The major findings of the study were that children and adults who were novices in their use of the programming language Basic used similar verbal approaches to learn Basic and made the same percent of correct responses on the computer.

There are relatively few tasks on which the performance of fourth and fifth graders equals that of adults and it is especially difficult to think of any academic skill where this is the case. How then does learning a computer language differ? Computers may be one area in which adults are truely novices. Children, although they may be novices in their use of a programming language, seem to be more at ease in the world of electronics. The adults in this study were quite naive about what a computer is capable of

doing and many responded initially as if the computer was only a complex typewriter. It is possible that the adults may have had more sophisticated strategies upon which to call than the children but, if so, they were not used in any way measured here. Some of the adults approached the task with negative perceptions about their capabilities, equating programming to mathematics, or a computer to a tool only for the mechanical minded. The children, on the other hand, were positive or neutral about attempting the task. The higher percentage of negative responses on the part of adults, 7%, to 2% for children may reflect these prejuduces.

For all subjects on-task performance was virtually 100% which highlights the computer's enormous potential as a teaching tool. The fact that so many questions were directed to the examiner during the sessions would seem to indicate that the self-teaching manual used in this study, and most likely many others, are not self explanatory, and the role of a teacher is important when learning a computer language.

The computer as an equalizer between young and old raises intriguing questions about classrooms of the future where teacher and student may share equal knowledge.

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Table 1

Percentage of Verbal Operations by

Category for Adults vs. Children

Category	Adults (N=1017)	Children (N=947)
Questioning		
To Self & Computer	0	1
To Examiner	24	28
Planning Statements	9	12
Monitoring & Checking	46	46
Evaluative Statements		
Self - Positive	2	2
Self - Negative	6	5
Computer - Positive	5	4
Computer - Negative	7	2
Non-computer Related	1	0
Total	100	100

Table 2

Number of Computer Operations, Errors

and Percentage of Correct Responses

for Adults vs. Children

Computer Operations	Adults	Children
Total Number of Operations	798	491
Total Number of Errors	133	105
Percentage Correct	83	79
SD	.10	.09